

Human Factors and Habitability Challenges for Mars Missions

As NASA is planning to send humans deeper into space than ever before, adequate crew health and performance will be critical for mission success. Within the NASA Human Research Program (HRP), the Space Human Factors and Habitability (SHFH) team is responsible for characterizing the risks associated with human capabilities and limitations with respect to long-duration spaceflight, and for providing mitigations (e.g., guidelines, technologies, and tools) to promote safe, reliable and productive missions. SHFH research includes three domains: Advanced Environmental Health (AEH), Advanced Food Technology (AFT), and Space Human Factors Engineering (SHFE).

The AEH portfolio focuses on understanding the risk of microbial contamination of the spacecraft and on the development of standards for exposure to potential toxins such as chemicals, bacteria, fungus, and lunar/Martian dust. The two risks that the environmental health project focuses on are adverse health effects due to changes in host-microbe interactions, and risks associated with exposure to dust in planetary surface habitats. This portfolio also proposes countermeasures to these risks by making recommendations that relate to requirements for environmental quality, foods, and crew health on spacecraft and space missions. The AFT portfolio focuses on reducing the mass, volume, and waste of the entire integrated food system to be used in exploration missions, and investigating processing methods to extend the shelf life of food items up to five years, while assuring that exploration crews will have nutritious and palatable foods. The portfolio also delivers improvements in both the food itself and the technologies for storing and preparing it. SHFE sponsors research to establish human factors and habitability standards and guidelines in five risk areas, and provides improved design concepts for advanced crew interfaces and habitability systems. These risk areas include: Incompatible vehicle/habitat design, inadequate human-computer interaction, inadequate critical task design, inadequate human-automation/robotic interaction, and performance errors due to training deficiencies.

To address the identified research gaps within each risk, SHFH's research plan includes studies in the laboratory, in analogs, and on International Space Station (ISS). In addition to establishing and maintaining the risk-based research portfolio, SHFH is also implementing a qualitative approach to determine how we at NASA evaluate human performance. Via interviews with experts, such as trainers, flight controllers, and flight surgeons, we are collecting the metrics by which they assess human performance, evidence of performance issues, and potential or actual consequences. The Human Performance Data Project will determine what human performance data have been collected in the past at NASA, and what data should be collected in the future in order to complete our knowledgebase and reduce risks related to human factors and habitability.